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Sparton XBT Qualification Test Results

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ABSTRACT

In January 1992 a U.S. Navy qualification test for Sparton of Canada T-7 (2500 ft) expendable bathythermographs (XBTs) was conducted in a region northeast of Barbados, where ideal conditions exist for such a test. A total of 416 T-7 XBTs (312 Sparton XBTs and 104 U.S. Navy inventory XBTs) were launched. Conductivity-temperature-depth (CTD) profiles were also made during the test. The results obtained from the qualifying test were used to determine if Sparton of Canada XBTs will be acceptable for use by the U.S. Navy. Sparton of Canada XBTs did not pass the qualifying test due to the large number of failures, most of which occurred during the zero speed, on station test segments.

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SPARTON XBT QUALIFICATION TEST RESULTS

INTRODUCTION

The expendable bathythermograph (XBT) was introduced in 1962 as a cost-effective device to collect temperature versus depth data by scientists and the military. The Navy uses XBTs to collect temperature profiles while underway. Sippican Incorporated is an approved source for XBTs based on previous test qualification programs and consistent production quality. Since the late 1960's Sippican Incorporated has been supplying the Navy with XBTs. Sparton of Canada, which also manufactures XBTs, approached the Defense General Supply Center (DGSC) and expressed an interest in competing for the Navy contract. In this technical note, Sparton of Canada XBTs are referred to as test XBTs. DGSC requested the Naval Sea Systems Command (NAVSEA) and the Naval Underwater Systems Command (NUSC) to develop performance specifications and test requirements to evaluate XBTs (References 1-3). In order to improve competition for XBTs, DGSC requested that the Naval Oceanographic Office (NAVOCEANO) provide ship time, equipment, and personnel to conduct the qualifying tests. The Naval Research Laboratory-Stennis Space Center (NRL-SSC), formerly the Naval Oceanographic and Atmospheric Research Laboratory (NOARL), agreed to perform the data analysis and produce this technical note, which provides the qualifying test results.

A qualifying test was conducted on the 2500 ft (760 m) T-7 XBT (OC-16/SSQ-56) in January 1992 aboard the USNS Bartlett in the area of 15°N, 57°W. This region of the North Atlantic Ocean is unique in that between about 400 and 800 m depths, there exist quasi-permanent isothermal/isohaline step-like features, which are ideal for testing vertical hydrographic profilers and expendable hydrographic probes.

DATA ACQUISITION EQUIPMENT

XBT data acquisition equipment, provided by NAVOCEANO and NRL-SSC, consisted of the following items:

2 Sippican model LM-2A shipboard launchers
2 Sippican model LM-3A handheld launchers
2 Sippican model MK-9 data acquisition interface units
2 Capital Equipment Corp, IEEE-488 interface boards
2 Zenith model Z-248 desktop computers

Software for XBT data acquisition, developed by NAVOCEANO, uses Navy standard temperature and fall rate conversion equations.

Conductivity-temperature-depth (CTD) data acquisition equipment, provided by NAVOCEANO and NRL-SSC, consisted of the following items:

2 Neil Brown Instruments System (NBIS) model MK-3 CTD underwater units
1 shipboard hydrographic winch
1 NBIS model 1150 data acquisition interface unit
1 Hewlett-Packard Vectra/286 desktop computer

NBIS Oceansoft V 3.0 software was used for CTD data acquisition.

DATA ACQUISITION PROCEDURES

XBT qualification test procedures, adopted by NAVSEA/NUSC, were followed throughout the qualifying test (References 2-3). The qualifying test was divided into five segments (Table 1). CTD profiles were taken during the zero speed on station segments. XBTs were launched with the CTD deployed in order to obtain accurate depth versus temperature measurements. These measurements were used to determine the accuracy of the XBTs launched on station. The maximum speed underway segments of the qualifying test were conducted at approximately 9-10 kt. No CTD measurements were taken during the underway segments. Procedures for launching the XBTs were identical for each segment, whether underway or on station. During each segment two XBTs were simultaneously launched. Initially, a Navy inventory XBT and a test XBT were launched. When these launches terminated two test XBTs were launched. This launch procedure continued until the designated number of XBTs for each segment were launched.

The LM-2A shipboard launcher and the LM-3A handheld launcher were used during the qualifying test to identify problems that might exist with either of these launchers. Both types of launchers are used extensively by the Navy; hence, any limitations regarding either type of launcher would be significant.

DATA PROCESSING

According to the qualifying test plan, each XBT profile is graded as either "pass" or "fail." Failures are classified into two categories:

1. Catastrophic failures result from;
    a. XBT fails to transmit any reasonable data.
    b. XBT profile is visibly offset in depth or temperature.
    c. XBT fails to reach a depth of 2500 ft (760 m).
2. Erroneous data failures are determined by analysis of the XBT profile as compared to other XBT profiles in the group and CTD profiles, if available.

Data processing began by producing plots of all XBT profiles to determine which XBTs were catastrophic failures. The remaining XBT profiles, not classified as catastrophic failures, were then converted to 1-m interval profiles using linear interpolation. CTD profiles were converted from pressure (dB) to depth (m) and then converted to 1-m interval

profiles using linear interpolation.

Temperature differences, at 1-m intervals, were calculated on all simultaneously launched test XBTs and Navy inventory XBTs. The range, mean and standard deviation of these temperature differences were then examined to determine if any significant errors were present between the two XBTs. Ideally, the mean and standard deviation of the differences would be close to zero. Mean and/or standard deviations of 0.2, or greater indicated a significant disagreement between the two XBT profiles. In cases where the mean and/or standard deviation was greater than 0.2 comparisons were made to other XBT profiles launched in the same time window and CTD profiles, if avaiable, to determine the source of error. When errors exceeded the specifications (Reference 1), the XBT was graded as a failure. For XBTs, when an absolute pass/fail decision could not be made, the XBT was graded as unresolved.

RESULTS

The results for the qualifying test are given in Tables 2-4. An unusually high number of catastrophic failures was noted during the zero speed on station segments. This was, in part, possibly due to interference of the hydrographic cable supporting the CTD. Therefore, catastrophic failures, on station, were divided to indicate the status of the CTD at the time of the XBT launches. The large number of unresolved XBTs from the underway segments are a result of not having accurate CTD data to compare to borderline XBT profiles. Unresolved XBTs were counted neither for nor against the total used in calculating failure percentages. Percentage of failures was calculated by:

1. Adding catastrophic and erroneous failures to get total failures.
2. Subtracting unresolved XBTs from total launched.
3. Dividing total failures by total launched.
4. Multiplying by 100.

Maximum speed underway test failure rate for the test XBTs was 5.6%. Zero speed on station test failure rate for the test XBTs was 35.0%. Total failure rate for the test XBTs was 15.9%.

According to the qualification test plan (Reference 3), the test XBTs must obtain 95% reliability at a 90% confidence limit in accordance with the military specifications (Reference 1). The total number of test XBTs used for reliability calculations is 296 (312 total test XBTs - 16 unresolved test XBTs). The maximum number of failures allowable for a 95% reliability rate at a 90% confidence is 10. This gives a maximum failure percentage of 3.4% (10 ÷ 296 * 100). Based on the test results, the test XBTs do not qualify for U.S. Navy use (Reference 3).

Table 1. XBT Qualifying Test Segments

XBT QUALIFYING TEST SEGMENTS				
Segment Number	Ship's Speed	XBT Type		CTD Deployed
		Test XBT	Navy XBT	
1	0	33	11	Yes
2	9-10 kt	102	34	No
3	0	36	12	Yes
4	9-10 kt	102	34	No
5	0	39	13	Yes
Total		312	104	

Table 2. Results for underway test segments.

UNDERWAY RESULTS		
	TEST XBTS	NAVY INVENTORY XBTS
TOTAL LAUNCHED	204	68
CATASTROPHIC FAILS	9	2
ERRONEOUS DATA FAILS	2	0
UNRESOLVED	11	0
PERCENT FAIL*	11/(204-11)*100 = **5.6%**	2/(68-0)*100 = **2.9%**

Table3. Results for on station test segments.

ON STATION RESULTS		
	TEST XBTS	NAVY INVENTORY XBTS
TOTAL LAUNCHED	108	36
CATASTROPHIC FAILS-CTD DEPLOYED	16	5
CATASTROPHIC FAILS-CTD ON DECK/AT SURFACE	18	3
UNRESOLVED	5	5
ERRONEOUS DATA FAILS	2	0
PERCENT FAIL*	36/(108-5)*100 = **35.0%**	8/(36-5)*100 = **25.8%**

* Percent Fail = Total Failures/(Total Launched-Unresolved)*100

Table 4. XBT qualification test results.

XBT QUALIFICATION TEST RESULTS		
	TEST XBTS	NAVY INVENTORY XBTS
TOTAL LAUNCHED	312	104
TOTAL FAILS	47	10
TOTAL UNRESOLVED	16	5
PERCENT FAIL	47÷(312-16)*100 = **15.9%**	10÷(104-5)*100 = **10.1%**

REFERENCES

1. Military Specification, Surface Ship Expendable Bathythermograph (XBT) OC-14/SSQ-56 ("T-4"), OC-16/SSQ-56 (T"-7") NAVSEA/NUSC, August 1990, Rev. A November 1990.

2. Primary At-Sea Test of Shiplaunched Expendable Bathythermograph Probes OC-14/SSQ-56 ("T-4"), OC-16/SSQ-56 ("T-7") NUSC, Code 432, August 1990, Rev. A November 1990.

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